# Current state and challenges in WEEE recycling industry in Serbia

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**Abstract**
Waste from electrical and electronic equipment (WEEE) is defined as a special waste flow due to the fact that contains hazardous materials and should not be mixed and treat with other waste streams. In order to ensure adequate environmental protection and proper management of this waste flow, Serbia has harmonized its legislation in this field with the EU regulations. However, main objectives are still not implemented, mainly because undeveloped separate collection scheme and lack of advanced treatment technologies. Also, EPR principles are still not fully established, including issues in ensuring stabile financial support for treatment operators. In this paper, an overview of the current situation, as well as problems and challenges in the management of WEEE in Serbia, with the focus on the recycling industry, will be addressed.
**Keywords:** WEEE, recycling, pre-treatment, Serbia

## 1. General overview of WEEE management in Serbia

The Republic of Serbia (RS) as EU candidate country through national legislation, harmonized and adopted the majority of the WEEE Directive 2012/19 requirements with certain targets postponed in relation to the legislation currently valid for EU member states (Diedler et.al., 2018). There are no precise data on generated WEEE on national level, but estimated generation rate is 11.1 kg/cap/year, which corresponds to 80,000 tons annually (Marinkovic et al. 2017). Current collection system is based on producer responsibility principles, where producers and importers of EEE are required to pay a certain fee (depending on the EEE type), which aims at establishing appropriate management of WEEE. Recycling and other treatment companies are then subsidized per tone of treated WEEE. However, collection schemes are still semi-established, since majority of WEEE (especially small categories of WEEE from households) are still disposed at landfills together with other municipal solid waste. It is estimated that about 2.78 kg/cap/year of WEEE is collected in Serbia (Diedler et.al., 2018).

## 2. Recycling of WEEE and identified challenges

The recycling system in Serbia mostly is relied on conventionally applied pre-treatment processes (Batinic et.al., 2018), where separation of valuable and hazardous components from WEEE flow are manually separated, with mechanical treatment only for certain WEEE types, such as refrigerators, CRT screens, fluorescent lamps, etc. Currently applied pre-treatment methods are usually customized for separation and recovery of “mass relevant” fractions, mostly metals (Fe, steel, Ni, Al, Cu, brass), but also non-metallic fractions, like plastic, glass, rubber, wood, textile etc. Hazardous materials and components removed within the pre-treatment stage are usually exported to final treatment in some of the EU countries. According to estimated data between 15,000 and 20,000 tons of e-waste are recycled, what makes only 20% of the total generated quantity. Although that recycling of WEEE represent perspective part of industry in Serbia, it still didn’t reach the expected level. The main reason for this is fact that eco-tax, i.e. fee payed by producers and importers of EEE is not recognized only as “dedicated” fund (e.g. Green Fund) for establishing of appropriate WEEE management, but it goes to Ministry of Finance and used for various finance applications in the country. Thus, recycling of WEEE is still not fully economically justified. Besides, in the current conditions, subsidy for recycling industry is paid on yearly basis, i.e. after the work is done through the whole year, but although the recyclers should be paid per tone of treated WEEE, dedicated subsidy in previous years covered only 60% - 70% of treated amounts. In addition, although that fee collected based on the “polluters pays” principle increasing by every year (e.g. 30% more in 2018 in comparison to previous year) the allocated budget for recyclers remained at the same level, with note that there is still an old unpaid debt for period 2016-2018. Thus, recyclers often need to cooperate with commercial banks in order to finance ongoing production, which doesn’t leave room for development, but only for covering operational costs. Additional problem is fact that for the most of hazardous components separated during the pre-treatment process there is no appropriate facilities for their final treatment in Serbia, so recyclers are forced to transport and pay processing of hazardous components from WEEE

abroad. This represents a significant financial expenditure for recyclers - for example, the cost of transporting and final treatment of freon costs about 75 €/kg.

*2.1 Case Study – Recycling plant in Niš*

Major center for recycling of WEEE in Serbia is located in Niš. Recycling plant was established in 2010 and by 2016, about 70,000 tons of different WEEE categories were recycled. Designed capacity of the facility is 21,000 tons/year, but currently with license to treat 14,000 tons of WEEE per year. Company play the role of WEEE collector as well. The largest amount of collected WEEE represent cooling devices (approximately 3,000 tons per year), TVs (CRT) with about 2,900 tons/year and large household appliances (about 3,600 tons per year). Treatment process is mostly based on sorting of WEEE flow by categories and manually separation of components. After the separation, components such as batteries, hard drives, printed circuit boards, cathode ray tubes etc., are usually sent abroad for further processing. CRT monitors undergoes to dismantling, where workers manually separate valuable/hazardous parts. After pre-treatment, glass is divided on toxic elements that contains lead and exported for further treatment, and non-toxic parts which are sent to cement factories in Serbia. One part of plant (MEWA) is specially designed for mechanical treatment of cooling devices and similar WEEE categories. Before mechanical stage, removal of glass, wood, wires, compressors and especially freon is crucial. Mechanical stage starts with size reduction, using shredding and crushing processes. After the size reduction, with magnetic separation a group of ferrous metals is separated, followed by separation of non-ferrous metals from other materials. Obtained outputs from the mechanical process are iron, aluminum, copper and plastic with purity of 99% and size of 0.1 – 1,000 mm. Freon undergoes to condensation process, after which is being frozen and again condensed and packed into special bottles and as such sent to Germany for the further treatment (about 16.7 t/year). One of the biggest problems is polyurethane foam because of the large amounts that are generated during the recycling process (more than 600 t/year) without appropriate possibility for its utilization in Serbia.

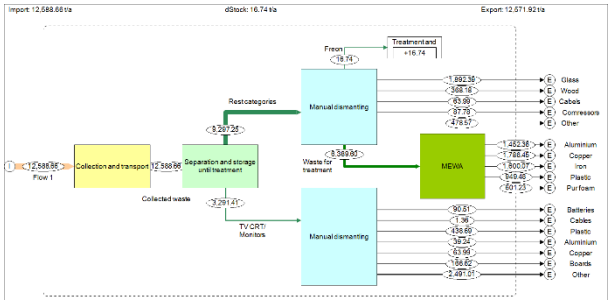


**Figure 1.** Material flows of different output fractions and components in observed facility

Considering overall material flows in plant (Figure 1.), it can be concluded that most of valuable output fractions coming from mechanical treatment of cooling devices, where about 1,600 t of iron, 1,450 t of aluminum and 1,780 of copper are extracted. There is also considerable amount of plastic obtained from this process (about 950 t/year), which together with plastic separated from other treatment units correspond to about 1,390 tons in total. Besides metals (Fe, Al and Cu), main output fractions and components obtained from the manual dismantling units in facility are cables, glass, wood, compressors, batteries, PCBs, etc., with quantities shown in Figure 1. In general, after the treatment all valuable obtained raw materials, if there is possibility, are further used as secondary raw materials in Serbia (for example Cu, Al and Fe are selling to smelting facilities), while output components and fractions, such as batteries with no possibility of local treatment, are exported.

## 3. Conclusion

Although recycling system of WEEE in Serbia is established, there are still techno-economical burdens that negatively influence on recyclers in order to have sustainable business. Besides low collection rate and insufficient quality of collected WEEE, the main issue for recyclers is reflected in fact that subsidy received from "eco-tax fund" is lesser for about 30% than the work done, i.e. treated quantities of WEEE. Thus, received subsidy is enough only to cover operational costs for treatment. Also, mentioned national Fund should be filled and spent in a transparent way only for purposes for which is intended. One of request from recyclers is also that subsidy be paid at least quarterly and not annually, which will allow recyclers to invest more in quality and processing of WEEE. Enabling conditions to establish appropriate facilities for final treatment of hazardous components that are extracted from the WEEE, can also have positive impact on fostering of circular economy principles and reducing of overall costs of WEEE recycling on national level.


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